ToD & DyP : A planning solution for efficient navigation in changing environments

Thomas Lopez, Fabrice Lamarche, Tsai-Yen Li

ToD & DyP :
A Planning Solution for Efficient Navigation in Changing Environments

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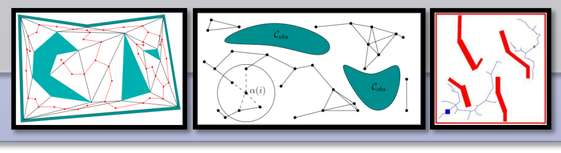
Problem statement

Path Planning has been widely studied in robotics to provide robots with autonomy of navigation.

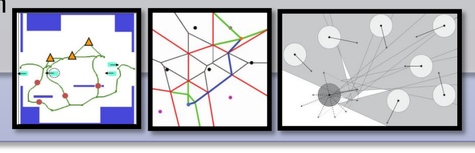
Static Environments

- Cell decomposition
  - Grids, Delaunay, …
- Probabilistic methods
  - PRMs and variants, RRTs, …



Dynamic Environments

- Mainly focuses on obstacles avoidance during navigation
  - Lazy PRMs coupled with RRTs, Velocity obstacles, Rapidly computed Voronoi diagram

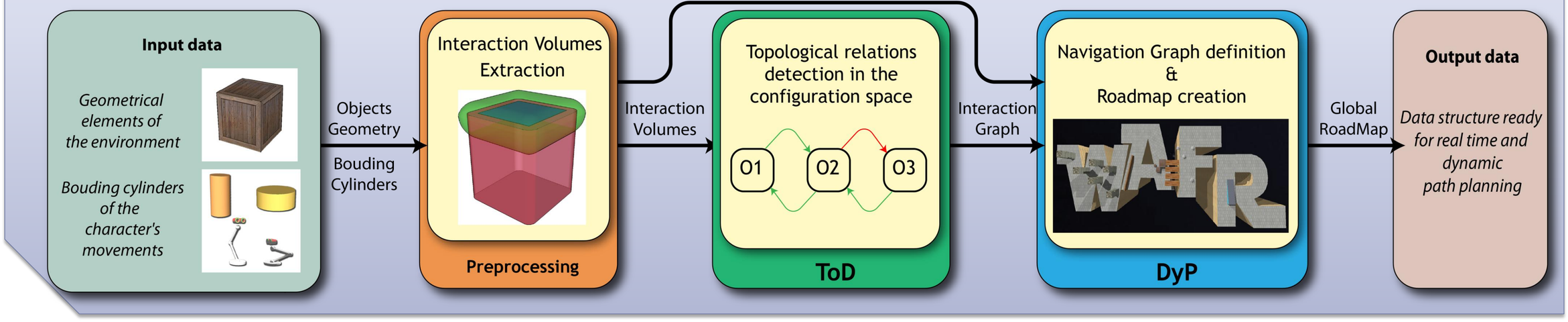


Changing Environments using available objects for navigation

- No solution propose to handle navigation of autonomous characters in changing environments where moving objects are obstacles but also *helpful navigable areas*

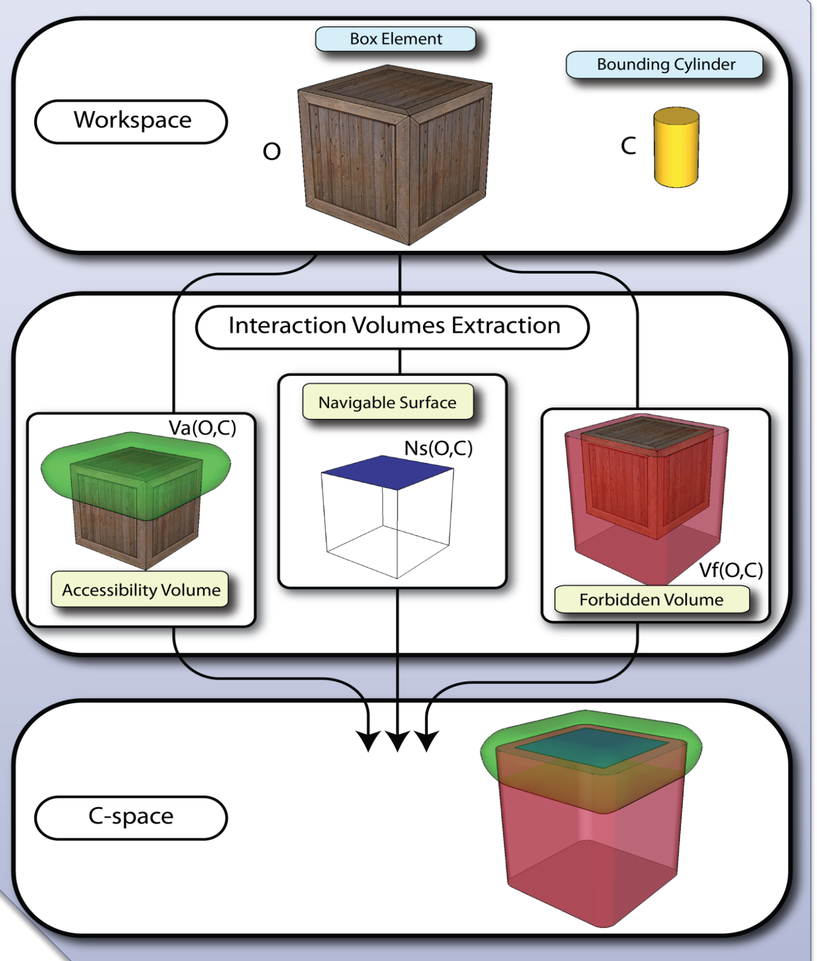
ToD & DyP : Overview

Characterize configurations between an object and a given entity. → Detect topological relations between objects → Compute paths through objects, interconnect roadmaps, computes local paths on selected objects.



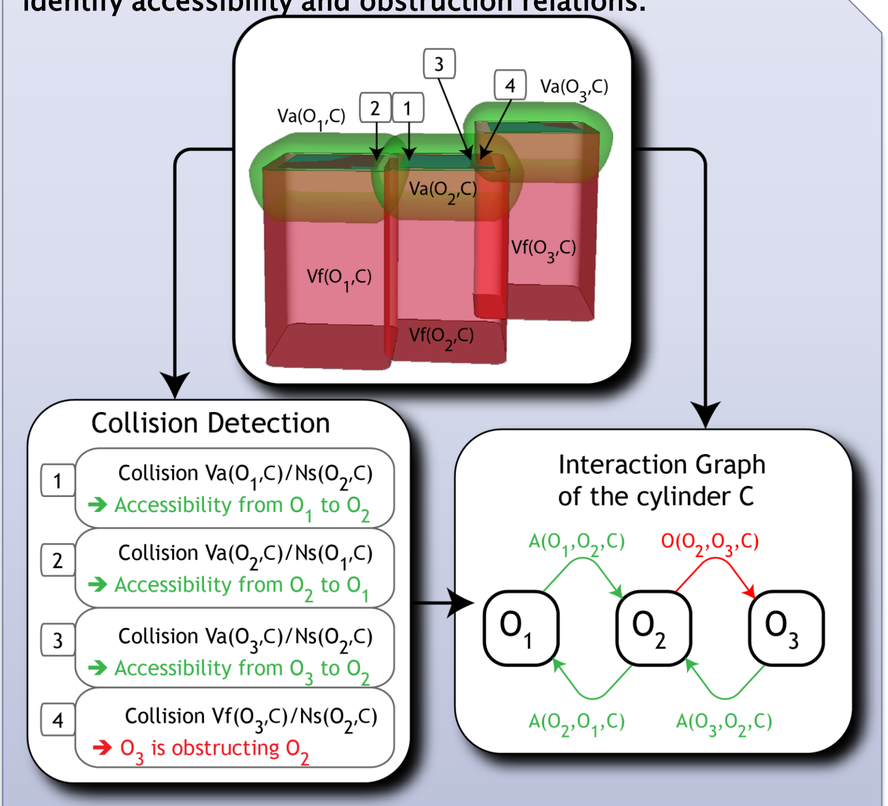
Interaction Volumes

Representing interactions between cylinders bounding an entity's motions and a geometric object.



ToD : Topology Detection

Computing intersections between *Interaction Volumes* to identify accessibility and obstruction relations.



-> Characterization achieved by using collision detection algorithm between *Interaction Volumes*

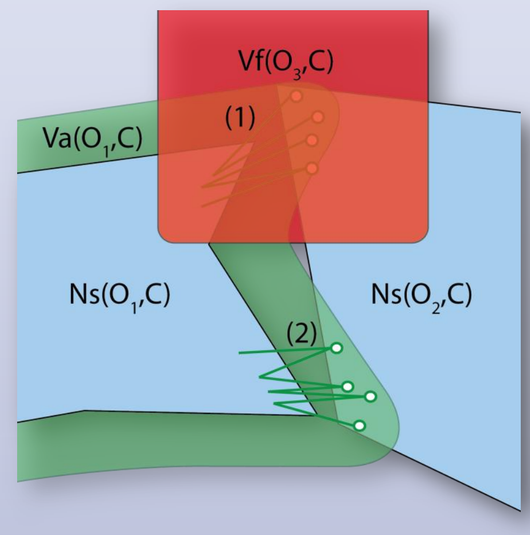
-> *Interaction Graph* construction: coarse and anytime representation of the workspace's topology

DyP : Dynamic Planner

- Local **roadmaps generation**
  - Using PRM, cell decomposition, …

- Local **roadmaps interconnection**

Example : Connection from O_1 to O_2 using *Interaction Volumes*

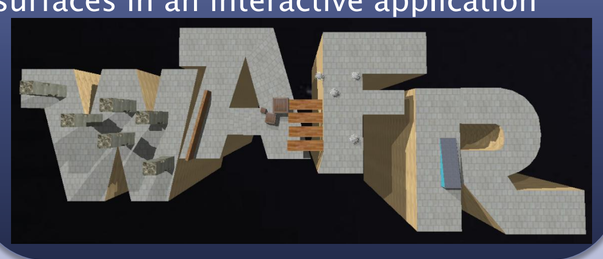


- **Two-level path planner**:
  - Identification of Navigable Areas that must be crossed
  - Local Path Planning on each identified Areas

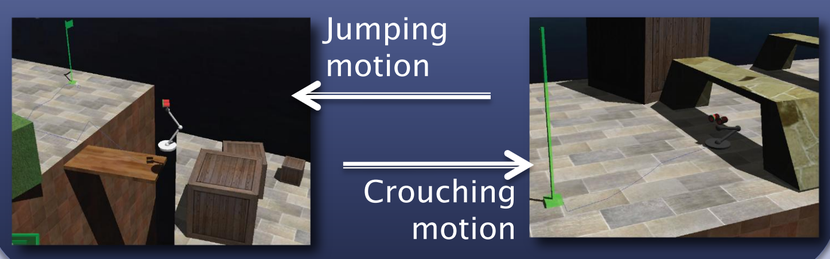
Results & Conclusion

-ToD & DyP address a **new and complex path planning problems** in changing environments:
  - Elements of the workspace → **obstacles and navigable areas** during the navigation task
  - Navigation capabilities of the entity → **characterize colliding and feasible configurations** of the C-space
- ToD & DyP tracks modification in the topology at any time and efficiently adapt computed paths

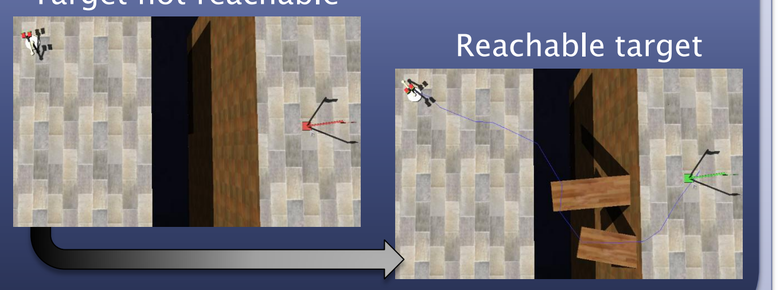
Our results show that the entity is able to find its path while avoiding obstructed areas and through unconnected navigable surfaces in an interactive application



Using different capabilities the entity is able to accurately navigate in a changing and disconnected environment.



On-the-fly detection of topological changes



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